Yb-doped YAG ceramic materials are often proposed to substitute single crystals as the active source in solid state lasers, mostly due to the advantages of the ceramic processing with respect to the single crystal growth process. Ceramics are prepared with a fast, cost-effective and flexible process, can be shaped with complex geometries and with a controlled dopant distribution and exhibit outstanding laser efficiency. Thus, ceramics represent the ideal candidate for high power laser materials. The presented work deals with the production of ytterbium-doped yttrium aluminum garnet (Yb:YAG) transparent ceramics. The materials were prepared from commercial oxide powders and processed to transparent quality by vacuum sintering.

Structured ceramics

To deteriorate the thermal efficiency at high thermal loading (high power), structured doping is proposed: materials with layered and gradient dopant concentration distribution. [1]

Tape casting

The tape casting method is based on the casting of a suspension with plasticizers and binders on a plastic sheet in order to obtain a thin layer (tape) which remains flexible after drying. The tapes can be assembled, stacked and united into a single bulk piece by compression at elevated temperatures (60 – 100 °C).

Layered structure is obtained by stacking of tapes with different dopant content. [4]

Conclusions

- The obtained materials are Yb-doped YAG ceramics with a homogeneous microstructure and good optical quality, and have been successfully tested as laser gain media.
- The concentration of silica (sintering additive, introduced by TEOS) was measured by LIBS. A major evaporation of silica occurs during vacuum sintering.
- Thermal conductivity of YAG with different Yb content was measured. The addition of dopant leads to a decrease of conductivity and thus complicates the cooling of the laser.
- Some of the thermal issues may be prevented by the design of the dopant distribution within he laser gain medium.
- Complex structures can be prepared via the ceramic process, in particular using the advantageous tape casting process followed by thermal compression.
- Layering by subsequent pressing has proved to be a fitting method for the preparation of transparent ceramics with unidirectionally controlled doping concentration.

References of interest


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